



Agricultural Research Service Energy Research

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Agricultural Research Service (ARS)

- In-house research arm of USDA
- Base funded (not a granting agency)
- Research is managed through national programs



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ARS Mission

Conduct research to develop and transfer solutions to agricultural problems of high national priority



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ARS Research

- Managed under 22 National Programs
- Obtain customer input to maintain relevance
- Reviewed through the Office of Scientific Quality Review to assure quality
- Transfer research findings (Office of Technology Transfer) to maximize impact and benefit



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National Program 307

- Energy research in ARS is managed under National Program 307, Bioenergy and Energy Alternatives
- In the ARS Crop Production, Product Value and Safety area.



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NP 307 Vision

America's energy needs met
using renewable resources



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NP 307 Mission

To create jobs and economic activity in America, reduce the Nation's dependence on foreign oil and improve the environment by developing alternate energy sources and increasing the use of agricultural crops as feedstocks for biofuels.



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Interactions with Other ARS National Programs

*Animal Production, Product Value and
Safety Area*

- NP 101 – Food Animal Production



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Interactions with Other ARS National Programs

Crop Production, Product Value and Safety Area

Bioenergy is very closely linked to the
biobased product research managed under
NP 306 – Quality and Utilization of
Agricultural Products



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Interactions with Other ARS National Programs

The Bioenergy and Energy Alternatives National
Program also interacts with these crop programs:

- NP 301 – Plant, Microbial, & Insect Genetic Resources, Genomics and Genetic Improvement
- NP 302 – Plant Biological & Molecular Processes
- NP 303 – Plant Diseases
- NP 304 – Crop Protection and Quarantine
- NP 305 – Crop Production



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Interactions with Other ARS National Programs

Natural Resources and Sustainable Agricultural Systems Area

Each of the seven programs in this area contribute to or are affected by energy issues. The programs are:



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Interactions with Other ARS National Programs

- NP 201 – Water Quality and Management
- NP 202 – Soil Resource Management
- NP 203 – Air Quality
- NP 204 – Global Change
- NP 205 – Rangeland, Pasture and Forages
- NP 206 – Manure & Byproduct Utilization
- NP 207 – Integrated Agricultural Systems



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ARS Bioenergy and Energy Alternatives Action Plan

As with each of the other National Programs, an action plan was developed from input provided by a broad group of customers and stakeholders. This input is obtained in a variety of ways, with the biggest input coming at a national program workshop held specifically to learn about problems, issues, and concerns.



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ARS Bioenergy and Energy Alternatives Action Plan

Components:

- Ethanol
- Biodiesel
- Energy Crops
- Energy Alternatives for Rural Practices



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Ethanol Projects

- Eastern Regional Research Center (Wyndmoor, Pennsylvania)
 - Corn-Ethanol Process Cost Reduction
 - New Biobased Products to Increase Demand for Grains



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Ethanol Projects

- National Center for Agricultural Utilization Research (Peoria, Illinois)
 - Bioprocess And Metabolic Engineering Technologies For Biofuels and Value-Added Co-Products
 - Utilization of Fuel Ethanol Residues For Value Added Co-Products



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Ethanol Projects

- Western Regional Research Center (Albany, California)
 - Conversion of Crops To Products With Higher Added Value Through Directed Molecular Evolution



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Ethanol Research Progress

Corn to Ethanol Process Cost Reduction

- Overcame an important barrier to, and reduced the cost of, separating zein, a major corn protein, from ethanol byproducts



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Ethanol Research Progress

New Biobased Products To Increase Demand For Grains

- Demonstrated a new corn steeping process using enzymes to reduce or eliminate the need for sulfites that can produce serious environmental and health risks. The process also reduces steeping time and cost



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Ethanol Research Progress

New Biobased Products To Increase Demand For Grains

- Developed a lower cost method to produce a unique cholesterol-lowering oil found in corn fiber
- Demonstrated that several types of food-grade and industrial gums that now must be imported can be obtained from various parts of the corn kernel



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Ethanol Research Progress

New Biobased Products To Increase Demand For Grains

- Identified alternative milling technologies that produced germ and fiber fractions that are superior in yield of valuable phytonutrients and that increase the value of corn fiber oil, corn fiber gum, and other valuable co-products



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Ethanol Research Progress

New Biobased Products To Increase Demand For Grains

- Optimized a process to produce a “quick fiber oil” with high levels of phytosterols



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Ethanol Research Progress

Utilization of Fuel Ethanol Residues for Value Added Co-products

- A sequential fermentation scheme was devised for the production of the valuable sugar substitute, xylitol, from corn fiber sugars



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Ethanol Research Progress

Utilization of Fuel Ethanol Residues for Value Added Co-products

- Fundamental information was learned about the mode of action of a biomass cleaving enzyme (acetylxylin esterase) and process conditions were optimized for the enzymatic production of fermentable sugars from corn fiber, an abundant byproduct of the fuel ethanol industry
- Sugars from corn fiber were successfully fermented to ethanol



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Ethanol Research Progress

Utilization of Fuel Ethanol Residues for Value Added Co-products

- Biosensors are being developed that, with use of advanced computational methods, can monitor fermentable sugars derived from corn fiber to facilitate the commercialization of value-added co-products from corn



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Ethanol Research Progress

Bioprocess And Metabolic Engineering Technologies For Biofuels and Value-Added co-products

- Developed a series of recombinant ethanol-producing microorganisms that use all of the sugars in a mixture at equal rates, thus increasing ethanol yields and lowering projected ethanol costs when using biomass as a feedstock



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Ethanol Research Progress

Bioprocess And Metabolic Engineering Technologies For Biofuels and Value-Added Co-products

- Discovered enzymes for use in the conversion of cellulose and hemicellulose components of biomass to fermentable sugars
 - A glucose and cellobiose tolerant beta-glucosidase essential for hydrolysis of cellulose to glucose
 - A thermostable arabinofuranosidase useful for hemicellulose bioconversion



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Biodiesel Projects

- National Center for Agricultural Utilization Research (Peoria, Illinois)
 - Vegetable Oil-Based Alternative Diesel Fuels, Extenders, And Additives
 - Ignition And Combustion Characteristics Of Biofuels



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Biodiesel Projects

- Eastern Regional Research Center
(Wyndmoor, Pennsylvania)
 - New Processes For Obtaining Higher Value-Added Products From Agricultural Lipids



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Biodiesel Research Progress

Vegetable Oil-Based Alternative Diesel Fuels,
Extenders, And Additives

- Modeled oxidation degradation reaction kinetics to rapidly and accurately predict the oxidative stability of biodiesel fuel formulations
- Developed accurate test method for screening fuel antioxidants in minutes rather than the hours or days required for standard test methods



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Biodiesel Research Progress

Vegetable Oil-Based Alternative Diesel Fuels, Extenders, And Additives

- Showed that resistance to oxidation of biodiesel can be substantially increased by adding agents called antioxidants



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Biodiesel Research Progress

Ignition And Combustion Characteristics Of Biofuels

- Identified additives to reduce NOx exhaust emissions from biodiesel use



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Biodiesel Research Progress

New Processes For Obtaining Higher Value-Added Products From Agricultural Lipids

- Developed a simple two-step chemical procedure for the conversion of soapstock into simple esters for use as biodiesel
- Optimized the synthesis of ethyl esters of grease using fuel-grade alcohol



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Energy Crops

- Developing Management Strategies And Plant Germplasm To Improve Great Plains And Midwestern Grasslands (Lincoln, Nebraska)
 - Genetic Improvement Of Switchgrass For Biomass Fuel And Agronomic Traits For The Northern USA
 - Genetic Improvement Of Switchgrass For Agronomic And Biomass Fuel Production Traits
 - Evaluate Switchgrass And CRP Type Grasslands For Biomass Production
 - Grassland Weed Management With Plateau



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Energy-Crops Research Progress

Genetic Improvement Of Switchgrass For
Biomass Fuel And Agronomic Traits For
The Northern USA

- Demonstrated, by use of germplasm evaluation nurseries, the need for regional tests to determine adaptation zones for switchgrass cultivars



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Energy-Crops Research Progress

Genetic Improvement Of Switchgrass For
Agronomic And Biomass Fuel Production Traits

- Determined that it is highly feasible to genetically modify the feedstock quality of herbaceous plants using both conventional and molecular breeding technologies and identified nine areas in which research could be conducted to improve the conversion of herbaceous plants to bioenergy



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Energy Alternatives for Rural Practices

- Renewable Energy Systems For Water Pumping And Remote Electric Power Generation (Bushland, Texas)
 - Development and Testing of Renewable Energy Technologies for Agricultural Applications
 - Wind/hybrid Control Prototype Development
 - Small Wind Systems For Water Pumping And Electric Generation



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Energy Alternatives for Rural Practices Research Progress

Renewable Energy Systems For Water Pumping And Remote Electric Power Generation

- Determined that stand-alone wind systems can pump water to irrigate fruit trees and make available additional land for fruit production which is not currently being used because of non availability of pumping energy
- Demonstrated that wind-electric systems are reliable and can be used to pump water at remote locations.



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Energy Alternatives for Rural Practices Research Progress

Renewable Energy Systems For Water Pumping And Remote Electric Power Generation

- Found that for a 0.75 kW AC solar power water pumping system a 50 Hz, 205 V, 3-phase electric motor instead of a 60 Hz, 230 V, 3-phase electric motor improved pumping performance resulting in a daily water volume increase of 10 to 15%



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Energy Alternatives for Rural Practices Research Progress

Renewable Energy Systems For Water Pumping And Remote Electric Power Generation

- Determined that a cost effective solution for maintaining an adequate water supply for livestock is to combine a wind system with a portable generator, for low wind/high temperature months, to power a submersible motor and pump



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Energy Alternatives for Rural Practices Research Progress

Wind/hybrid Control Prototype Development

- Simulated the performance of a wind/diesel electrical system suitable for a village or large farm and found that when wind power was sufficient to curtail the diesel plant, control was smooth and stable providing for the entire load without having to burn diesel and average fuel savings of 22%



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ARS Bioenergy and Energy Alternatives Website

- <http://www.nps.ars.usda.gov/programs/programs.htm?NPNUMBER=307>
 - Action Plan
 - National Program Team
 - Locations
 - Research Projects
 - Annual Reports
 - and more



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ARS Website

<http://www.ars.usda.gov>



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